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Female Enrolments in STEM in Higher Education: Trend Analysis from 2003 – 2018: KNUST as a case study

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Abstract

Tertiary education in Ghana has experienced rapid growth in accessibility and participation. Ghana has made some positive and impressive progress towards increasing access to education and narrowing gender gaps at the pre-tertiary education levels. Yet, these developments have not translated commensurately in higher education level. This study investigates the effectiveness of the directives and the Vice-Chancellors' initiatives introduced and designed to increase female students' enrolment at the Kwame Nkrumah University of Science and Technology (KNUST). The study used enrolment data from KNUST, the university's initiatives and directives on female enrolments, KNUST recorders, online articles, publications, and ministry of higher education websites. The authors provide descriptive and critical trend analysis in females' share of science, technology, engineering, and mathematics (STEM) enrolments in Kwame Nkrumah University of Science and Technology, Kumasi-Ghana, for sixteen years. Results show that the directives and interventions geared towards the realisation of the increase in numbers of female enrolment have a positive effect on increasing enrolment of female students at the university. However, the data shows that the proportion of female students is still low in the Physical Sciences and Engineering disciplines than males though they outnumber the males in the Health Sciences.

Keywords: Gender equity, access to higher education, Affirmative action, Girl-Child education

Introduction

The underrepresentation of women in the job market is alarming, considering that women's education rate is high (Houjeir *et al.* 2019). Equipping women with knowledge and skill in science is necessary to achieve their full potential, contribute to an increasingly interconnected world, and ultimately convert better skills into better lives, which is the central preoccupation of policymakers across the globe (Alblooshi and May 2018). It is considered that Science, Technology, Engineering, and Mathematics (STEM) Education is the central element to achieve a knowledge-based economy.

Houjeir *et al*. (2019) stated that Science and Technology drive socio-economic and human development that underpins society and infrastructure. It is a significant factor in innovation and indeed in the rise and fall of civilizations. Scientists' work forms the link between scientific discoveries and their subsequent applications to human needs and quality of life. Therefore, the provision of knowledge platforms and opportunities for both men and women helps the scientific society broaden its achievements and, consequently, improve the industry outcomes and ensure a nation's sustainable development. However, the need to engage more women to study STEM subjects is a worldwide challenge, and Ghana is no exception.

The participation of women in Science and Technology education has been and is still low worldwide (Kishore, 2008; Dasgupta and Stout, 2014). The United Nations (U.N.) has recognized women's central role in the development and the importance of understanding the gender-differentiated effects of development planning. The Platform of Action of the Fourth U.N. World Conference on Women (1995) noted that women's empowerment and full social participation are prerequisites for achieving equality, development, and peace. Generally, women are under-represented in almost every area of recognized scientific activity (Kishore, 2008) though participation is increasing in the 21st century (British Council, 2001). This cut across every sector, including education.

In Ghana, university education has seen outstanding growth relating to accessibility and participation. According to Atuahene and Owusu-Ansah (2013), within 15 years, university education enrolment increased from below 9,997 in 1992 to more than 132,000 in 2010, representing an increase of 1,300% (13-fold). Their study further revealed that female enrolment has seen a considerable degree of improvement with a Gross Enrolment Ratio (GER) of 1.52% in 1999 to 9.24% in 2011 whilst male enrolment increased from 4.28% to 14.92%. It is evident that Ghana has made positive and impressive strides toward increasing access to education and narrowing gender gaps at the pre-tertiary education levels. Yet, these developments have not trickled down to the university education level. The Kwame Nkrumah University of Science and Technology (KNUST) is the second public university established in Ghana through an Act of Parliament (Act 80) in 1961. Total enrolment increased from 708 in the 1961/1962 academic year to 42,561 (64.1% males and 35.9% females) in 2015/2016 (KNUST Basic Statistics, 2016). The university has introduced many initiatives to increase students' enrolment with the rollout of less-endowed, fee-paying and staff/protocol students' admissions. Applicants from families of all income levels and Senior High Schools (SHS) have the opportunity to gain entry to KNUST to study STEM courses. In 2009, KNUST embarked on an initiative to deliberately increase the admission of females in STEM programmes. By this means, the aggregate score is lowered for female candidates applying to study a STEM-based programme. This practice ensures that female applicants who ordinarily would not have gained admissions competitively gain admission into these previously male-dominated programmes. This paper examines the effectiveness of the interventions using the trend analysis of female enrolments in STEM in KNUST, Kumasi-Ghana from 2003 to 2018.

Literature Review

Traditionally, there is a wide gender gap in higher education, however the same cannot be said for primary education since there are no real problems of access to primary education. The trend towards fewer girls in education starts to appear at the secondary school level and accelerates markedly in higher learning institutions. In this research, higher education as the proportion of tertiary education that leads to an advanced diploma or degree. Capraro and Nite (2014) define STEM as any teaching strategy that comprises integrating any two or more fields of science, technology, engineering, and mathematics. Sahin *et al*. (2014) defined STEM by connecting it with problem-based learning as an apparent result of an unclear task. Breiner *et al*. (2012) asserted that STEM has more than one meaning, as the abbreviation shows; for some educators, it can be different activities. It can be the replacement of the standard traditional method of teaching to a new scope.

Although STEM is universally known as connecting between its four disciplines, there are extensive arguments between educators about the disciplines in STEM; some Educators declare STEM as the only four disciplines (Capraro and Nite 2014; Sahin *et* al. 2014 and Breiner *et* al. 2012). Others proposed connections between science and engineering (Strimel et al., 2017), while some advocate other connection subjects. McDonald (2016) argued that STEM education in many schools concentrates on science and math only. In most cases, STEM is taught from the disciplines' perspective and not from an interdisciplinary perspective. Kasza and Slater (2017) and Asunda and Mativo (2015) shared the same opinion of the STEM education in many schools emphasizing Math and Science, which should be taught separately while technology and engineering are disregarded.

Effective STEM education depends on a rigorous curriculum and instructional approaches in Science and Math. For instance, there can be an integrated approach in teaching engineering design cycle and problem-solving, by augmenting inquiry strategies in all disciplines, encouraging collaboration, connecting students with their community, supporting multi-perspective viewpoints to develop interdisciplinary ideas and offering exploratory learning experience. Effective STEM education can also be achieved by using available technologies, comprising science and engineering practices, as well as project-based learning and problem-based learning (Kennedy and Odell, 2014; Storksdieck, 2016). The 21st-century generations need to be critical thinkers, creative members, be engaged in collaborative, cooperative as well as communicative enterprises in their groups. These skills smoothen the STEM teachers' job and help teachers accomplish problem-solving, engineering design projects and inquiry strategies (Asunda and Mativo, 2015). Again, discussion, collaboration, negotiation and communication skills are significant components of any task pursued (Morrison *et al*., 2015).

In Africa, the overall enrolment of women in higher education is still much lower than that of men. Worse still, women enrolment in science courses is still much lower. At the University of Science and Technology, now KNUST, women enrolment in 1986\87 made up 16% of students in the natural sciences, 2.1% in engineering, 21.9% in the medical sciences, 10.2 % in the agricultural sciences, and 10.9% in architecture. A 1992 study showed that less than 10% of the total enrolment in science and engineering courses in Nigerian universities are female (STAN, 1992), and there is little information on women's participation in Science and Technology Education in developing countries. Huyer and Westholm, (2000) carried out a study on women's enrolment in tertiary-level engineering, medical, and health-related courses in Africa, the Caribbean and Latin America and Asia. The research shows that participation in the engineering courses ranges from 1.6% in Kenya to 26.5% in Colombia. Also, for medical and health-related courses, where women are more highly represented around the world, the rate ranges from 24.7% in Kenya to 68% in Nicaragua, the exception being a participation rate of 77% in the Philippines.

However, empirical evidence regarding the question as to whether the exposure of women to Math and Science subjects at school translates into less gender difference in STEM enrolment is mixed. Legewie and DiPrete (2014) examined the provision of Math and Science in U.S. high schools. They found that the stronger the Math and Science orientation of the school's curriculum, the smaller the gender gap in intentions to major in STEM fields (see also Levine and Zimmerman, 1995). In contrast, some studies in Europe show that encouraging women to take science subjects in school does not necessarily increase subsequent female enrolment in STEM fields. Curriculum reform in England in 2006 and 2008 (the Triple Science policy) increased the number of female students taking up science subjects (Homer *et al.*, 2013). However, this increase did not translate into growing participation in STEM higher Education (Broecke, 2013).

On the contrary, according to Broecke (2013), increased learning intensity in sciences significantly affected the chances of doing a STEM degree in higher education for men only. The same gender pattern of men benefiting from intensified courses is reported in three studies that examine recent curriculum reforms in upper secondary education in Germany (Biewen and Schwerter, 2019; Görlitz and Gravert, 2018; Hübner et al., 2019). In contrast, in the Netherlands, a curriculum reform making Math and Science courses compulsory led to an increase in the number of female students participating in STEM exams and entering science-related fields of study (Langen and Dekkers, 2005).

Young people's aspirations may also be shaped by existing labour market structures, including the level of occupational segregation by gender and in particular, the extent to which same-gender role models are apparent in STEM fields (Moorhouse, 2017). Furthermore, occupational aspirations are established relatively early so that young women and men may have particular jobs and/or fields of study in mind even before exposure to STEM at the upper secondary level (Legewie and DiPrete, 2014a; Sikora and Pokropek, 2012). Current trends beg the question of whether or how the changing labour market and employment opportunities in the course of the current rapid digital transformation and digitalization will attract more students—of both genders—into STEM fields. All of this suggests the need for a broader conceptual framework and empirical research that comprehensively takes account of the role of labour markets, school structures, and individual experiences in shaping gendered subject choices.

Gender Equity and Access

Liberal feminism theory is rooted in the belief that women and men are rights-bearing and autonomous human beings. The liberal feminists' theory upholds the view that the abolition of gender segregation of occupational roles is necessary to achieve women's equality. Liberal feminists believe changes in equal opportunities and educational policies, e.g. the National

Curriculum, will end patriarchy (Agassi 1989). Issues concerning women have taken a new dimension and received varied treatment by the United Nations and its specialized agencies. The equality of men and women was first recognized in (1945) in the United Nations charter and subsequently in the universal declaration of human rights (Morley 2005). Since then, the U.N. has helped create a historic legacy of internationally-agreed strategies, standards, programmes and goals to advance the status of women worldwide. Over the years, the U.N. and its technical agencies have promoted women's participation as equal partners with men in achieving sustainable development, education, and full respect for human rights. The empowerment of women continues to be a central feature of the U.N.'s efforts to address social, economic and political challenges across the globe.

The World Education Forum of 2000 aimed at ensuring that by 2015, all children, particularly, girls under challenging circumstances and those belonging to ethnic minorities will have access to free and compulsory primary education of good quality. This was to eliminate gender disparities in primary and secondary education by 2005 and achieve gender equality in education by 2015. The focus is on ensuring girls have full and equal access to and achieve good primary education (Lihamba *et al.* 2006). This prompted the UNESCO World Conference on Higher Education (1998) to demand eliminating all gender stereotyping in higher education, envisaging elimination at all levels and in all disciplines in which women are under-represented and increase women's active involvement in decision-making.

According to Atuahene and Owusu-Ansah (2013), Ghana has comparatively distinguished itself among many Sub-Saharan African (SSA) countries in its educational developments. Over the past decade, Tertiary Education in Ghana has witnessed tremendous growth in various frontages, resulting in increased access and participation, relative expansion of academic facilities, a growing private sector, and more importantly, a transformative policy environment that encourages more women participation. There is a considerable body of work concerning gender-related phenomena in science and the under-representation of females, and these issues have been widely discussed in the international literature (Adamuti-Trache 2004; Blickenstaff 2005; Murphy and Whitelegg 2006; Brotman and Moore 2008). This study focuses less globally and more locally on the particular situation in Ghana. Gender equality and equity have long been a focus area of Ghana's government, bent on encouraging an appreciable increase in the enrollment of female students into higher education.

There was a study in Mauritius, MES Statistics (2010) where the overall statistics for girls' participation in biology and the physical sciences suggest a familiar tendency for girls to choose biology and biological sciences. While Brickhouse *et al* (2000) suggested that teachers dominate such subject choices, in Mauritius as elsewhere, parents and teachers exert variable influence on students' enrolment in science classes (Reid and Skryabinet al.3; Dalgeindicatedll 2004).

Jacob *et al.* (2020) state that limited exposure to STEM studies, which may occur in systems where studying a STEM subject is not compulsory and students are allowed to specialize in specific subjects, may lead to lower STEM enrollment levels. If students have the option of selecting their subjects, they can seek more intensive exposure to subjects in which they are interested, in which they are most likely to succeed or they deem to be more relevant for their future. In addition, not taking STEM subjects at the high school may disqualify students from taking particular fields in higher education and create challenges for studying such subjects without an adequate foundation in the discipline.

Some other Interventions/Programmes

WiSTEM - Women in Science, Technology, Engineering and Mathematics

The formation of WiSTEM$_{Gh}$ - Women in Science, Technology, Engineering and Mathematics, Ghana (WiSTEM$_{Gh}$) was officially launched at the Kwame Nkrumah University of Science and Technology on 19th October 2018. The role of WiSTEM is to mentor young female scientists and inspire young females to take up STEM careers. The formation of WiSTEM$_{Gh}$ is expected to facilitate an appreciable increase in female enrolment in science and technology programmes. So far, two Girl's Camps, aimed at creating equal opportunity for all girls to boost their interest in STEM education have been organised. In line with its mandate, WiSTEM$_{Gh}$ is committed to putting in efforts to improve STEM education as part of its corporate social responsibility. Female scientists in KNUST have mentored young girls from secondary schools in Kumasi and its environs to pursue STEM programmes to contribute to Ghana's economic growth and the world in general.

MasterCard Foundation's Scholarship Programme (MCFSP)

MCFSP provides access to secondary and higher education for young people who desire to be ethical and transformative leaders committed to giving back to their communities. MCFSP at KNUST in Ghana is a partnership between KNUST and the Mastercard Foundation (MCF) which has its headquarters in Toronto Canada. The aim is to train altogether 2,250 scholars over a 15 year period (750 Scholars in Phase I - 2014-2019 and 1500 Scholars in Phase II - 2019-2029) who will contribute significantly to societal change and Africa's transformation by empowering the youth of the continent.

The programme seeks to provide quality higher education to the academically talented yet economically disadvantaged qualified students in Africa's deprived communities. In its mandate, priority is given to Females, Displaced Persons (Certified Refugees and Internally Displaced Persons) and Persons with Disability. It has recruited 750 scholars (400 Males / 350 Females) in 6 cohorts for its Phase 1. Out of this 750, 335 are pursuing STEM programmes (200 Males and 135 Females).

In previous years, the regional distribution made it somewhat difficult to recruit more young women. Affirmative action was taken to recruit more females; by selecting young women who meet the minimum requirements to enrol into the university with an uneven regional distribution. Thus, at the end of the recruiting period of Phase 1, the ratio of male to female was 400 (53.33%):350 (46.67%). Further to this affirmative action, the Mastercard Foundation's new expansion directive in building on results is by encouraging partners to adopt bold and innovative ideas that will contribute to the objectives of this expansion. The main objective of this expansion is to enrol and graduate an additional 15,000 young people in high-quality tertiary education, and leadership development by 2030; with 70% being young women, **25%** being displaced youth, and **10%** being young people with disabilities. It would ensure gender-specific support, including activities, policies, interventions, and targets that aim to advance gender equality and gender transformation at an institutional level.

Challenges of Females for STEM programmes

Family and community's outlook on life impacts girls' education, such as their academic choices and career aspirations. However, it is essential to report that generally, educated parents value education greatly. However, there can be gender differences in how they influence their children's educational choices, consciously, or unconsciously. They might not inspire their daughters, for instance, to pursue science and engineering disciplines, or they may influence them to believe that these are unsuitable occupations for females. Another challenge could be the lack of role models, mentors, or sponsors. Research shows that many women have recognized isolation and limited mentorship or sponsorship as one of the crucial barriers to their progression in their professions (Blanchard and Blanchard 2020).

A study of the gender gap in 134 countries published by the world economic forum shows that the United Arab Emirates (UAE) is one of the fastest-growing economies in the middle east as well as being one of the most open societies with the assumption that women have more freedom in comparison with other countries in the Gulf region (Shallal, 2011). In the UAE, several measures have been put in place by the government to support women's participation in the workforce. Despite this, the numbers still show that women's workforce participation is less than men, which could be due to cultural factors. Ridgway (2017) reported that the support of government education for women is of great benefit. However, most of these women, especially the young and new graduates, do not need to join the workforce since they do not have any control over the family finances and depend on their male relatives to support them. Additional cultural norms might play a role in the employment choices where women are expected to take care of their children and they are forced to leave their employment as soon as they get married or give birth (Ridgway, 2017).

According to Bawa and Sanyare, (2013), decision and policymakers in Ghana, for example, understand the importance of women's role towards attaining the nation's economic objectives and have put in notable plans to inspire women to choose STEM fields and keep them in their chosen field. The continued support of women from the country's leadership over the past years has been a crucial factor in encouraging female students to study and stay in the STEM fields. The leadership in Ghana reveals their commitment to the belief that women must be given the appropriate platform to attain great accomplishments.

Gender stereotypes

These comprise the belief that Science and Math are male subjects and as a result, people often have negative attitudes to women in ‘masculine’ STEM careers. Sikora (2014) stated that many of the barriers to girls' participation in STEM education and STEM careers are entrenched into culture and gender stereotypes.

Social-psychological barriers: Women from early childhood to adulthood encounter social-psychological barriers to the STEM fields. Saucerman and Vasquez (2014) conducted a literature review to identify socio-psychological barriers to STEM field participation for women, organized by developmental stages – from early childhood to adulthood. For instance, parents trust that boys are more engrossed and proficient in STEM subjects and that STEM subjects are more challenging and less important for girls than boys.

Self-perceptions: Along with influences from parents and teachers, when girls move from childhood to youth, their self-perceptions and approaches to STEM are also influenced by their peers and the media. As most media describe STEM as a male-dominated area, it is not surprising that fewer females would recognize STEM as an area of interest.

STEM leadership roles: Small numbers of women partake in senior roles on funding and other decision-making bodies (Marginson, 2013). Nowadays, the leadership in Ghana demonstrate their commitment to the belief that women must be given the proper platform to achieve great accomplishments. The decision-makers in the country view women's issues as part of a larger effort towards overall national economic progress and are fully committed to supporting their empowerment.

Design / Method

Data analysis in this study seeks to determine the enrolment trend and the effect of interventions introduced to increase female students' enrolment at KNUST. The institution was used as a case study because it is the premier Science and Technology Higher Education Institution in Ghana with a present population of over sixty thousand students. KNUST offers a variety of disciplines in Engineering, Sciences and Humanities. Enrolment data was accessed via the KNUST admission information system. Sixteen years (2003/2004 - 2018/2019 academic year) of enrolment data were analyzed, being the available data at the time of research. Three STEM Colleges (Science, Engineering and Health Science) were used for the study. The data for the analysis was gathered from the KNUST Basic Statistics Publications. This analysis was based on quantitative methods and presented in statements, tables and figures; Microsoft Excel 2013 and R version 3.1.1 were used for the analysis.

Trend Test

To evaluate the existence of a trend in the data, two tests: Mann-Kendall Trend Test and Augmented Dickey-Fuller (ADF) test were used. The Mann-Kendall trend test is a non-parametric test which checks whether there is a trend in the time series data under the following hypothesis:

H_0:There is no existence of a trend in the data series

H_1: The existence of a trend in the data series

The ADF test checks whether a series is stationary or not. A non-stationary process means trend exists in the data.

Results and discussions

Descriptive Analysis of the Admission Process

Table 1 shows the descriptive statistics for KNUST admission into the STEM programme from the 2003/2004 – 2018/2019 academic year. The admission process begins with the receipt of applications, shortlisting of qualified applicants, and applicants' admission based on the quotas of the various programmes. KNUST has received a minimum of 5494 and a maximum of 23358 applications over the sixteen years with a spread of 53.96%. Out of the applications received a minimum of 1946 and a maximum of 7947 students enrolled to commence studies into the STEM programmes.

Table 1: Descriptive Statistics of KNUST Students of the various admission processes (2003/2004 – 2018/2019 academic year)

	Minimum	Maximum	Mean	Coefficient of variation
Applied	5494	23358	11988.875	53.96%
Qualified	4300	18210	9539.375	49.11%
Admitted	2590	11109	6203.250	48.11%
Enroled	1946	7947	4461.438	50.52%

Sources: KNUST Basic Statistics

In Fig. 1, generally, there is an increasing trend for both applicants and qualified students of KNUST from 2008 - 2012. However, in 2013, there was a sharp increase in the number of applied and qualified students. This is as a result of two batches (i.e. the 3rd year and 4th year batches) of the Senior High School (SHS) students who wrote the West African Senior School Certificate Examination (WASSCE) concurrently. However, the numbers reduced drastically in 2014 because only one batch of the SHS students wrote the examinations. Again, there is an increasing trend for students who were admitted and enrolled from 2012 - 2018.

Furthermore, in 2003, the total number of applicants was 5988 (Fig 1) of which 5379 representing 90% were qualified (Fig 2) and 2590 were admitted into the three (3) Colleges of STEM (representing an acceptance rate of 48%). However, this trend fluctuated as the number of applications increased in successive years. For example, in 2010, the total number of qualified applicants was 12160 (i.e., 91% of total applications). Out of this, only 70% of the qualified applicants were admitted to study in the three (3) STEM Colleges. The status of the 30% of students who could not gain admission remains unknown.

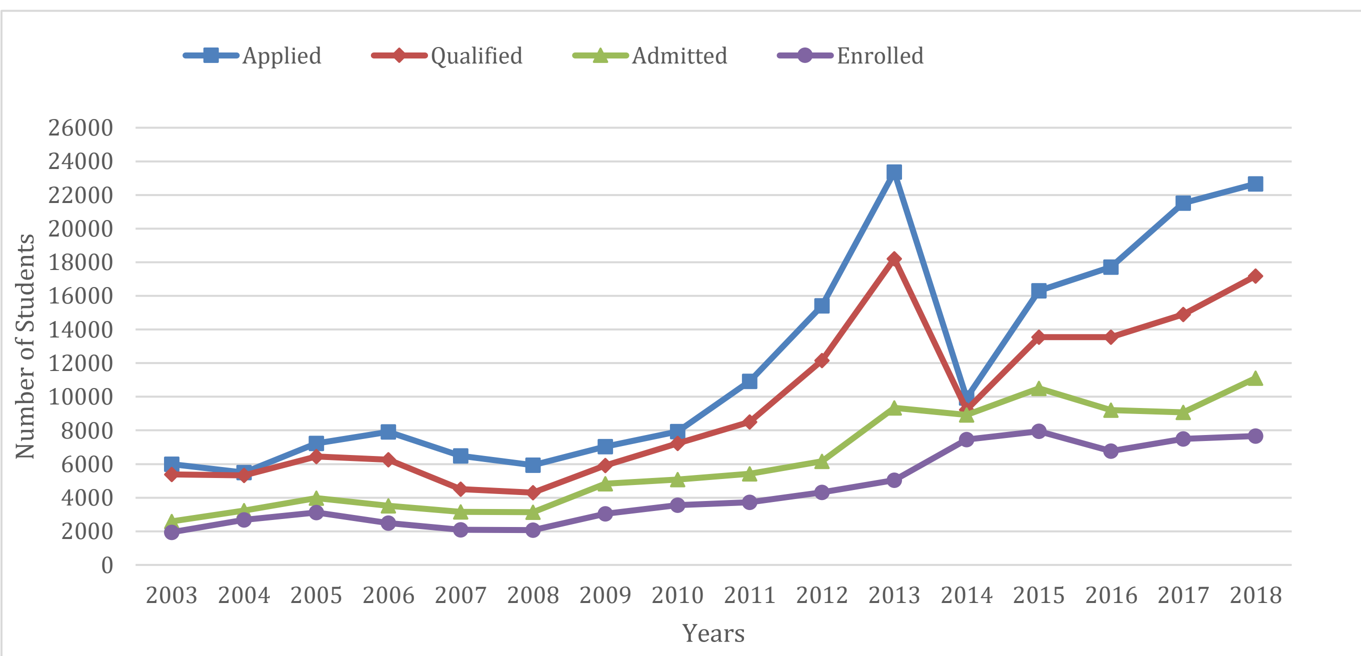


Fig 1: Time Series plot of the admission process at KNUST for general student population into the STEM programmes (2003-2018)

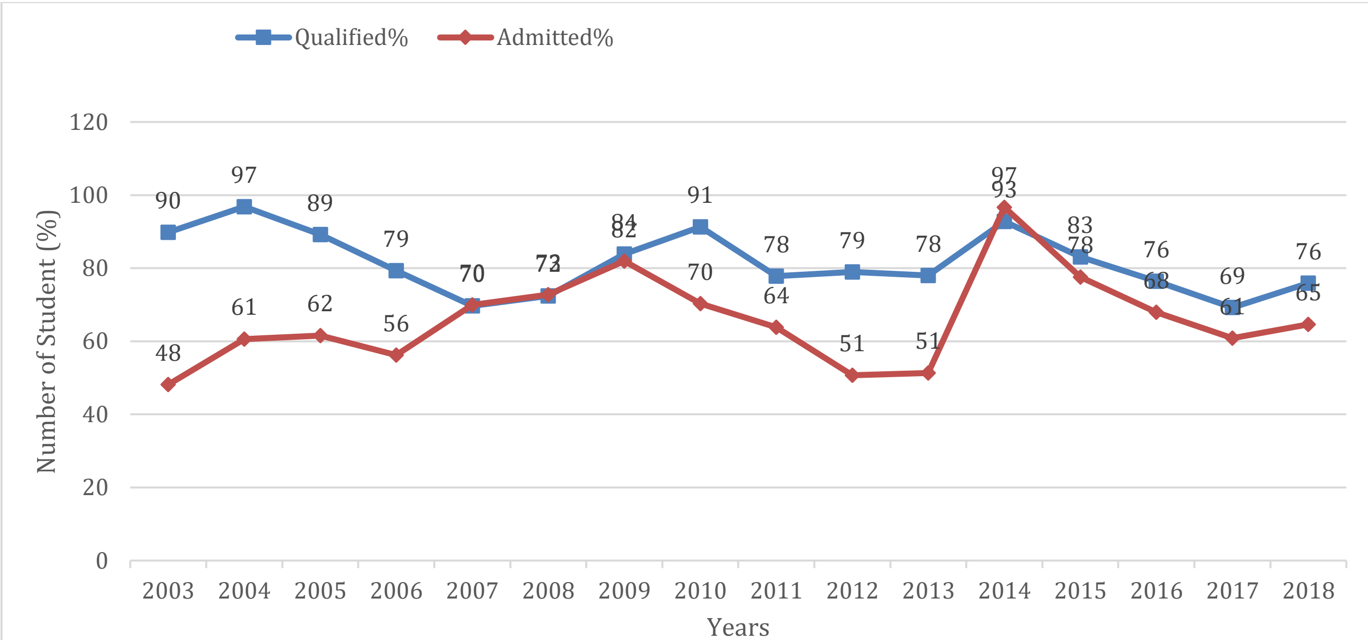


Fig 2: Percentage of qualified and admitted students of KNUST into the STEM programme (2003-2018).

Female Admission Trend

In Fig 3, there is a gap of qualified female students who are unable to gain admission into KNUST and again, the gap seems to be closing between 2015 and 2018. For instance, out of 6461 qualified female students in 2018 (i.e., representing 71% of the total applicants), only 64% (Fig 4) were admitted of which 36% could not secure admission. There seems to be an increasing trend in the number of enrolled female students in KNUST from 2007-2015. In 2015 the number of enrollment increased due to intervention by the university to deliberately increase female admission. Again from Fig 4, almost all qualified female students were admitted in 2008 to 2009 as well as 2014 to 2015.

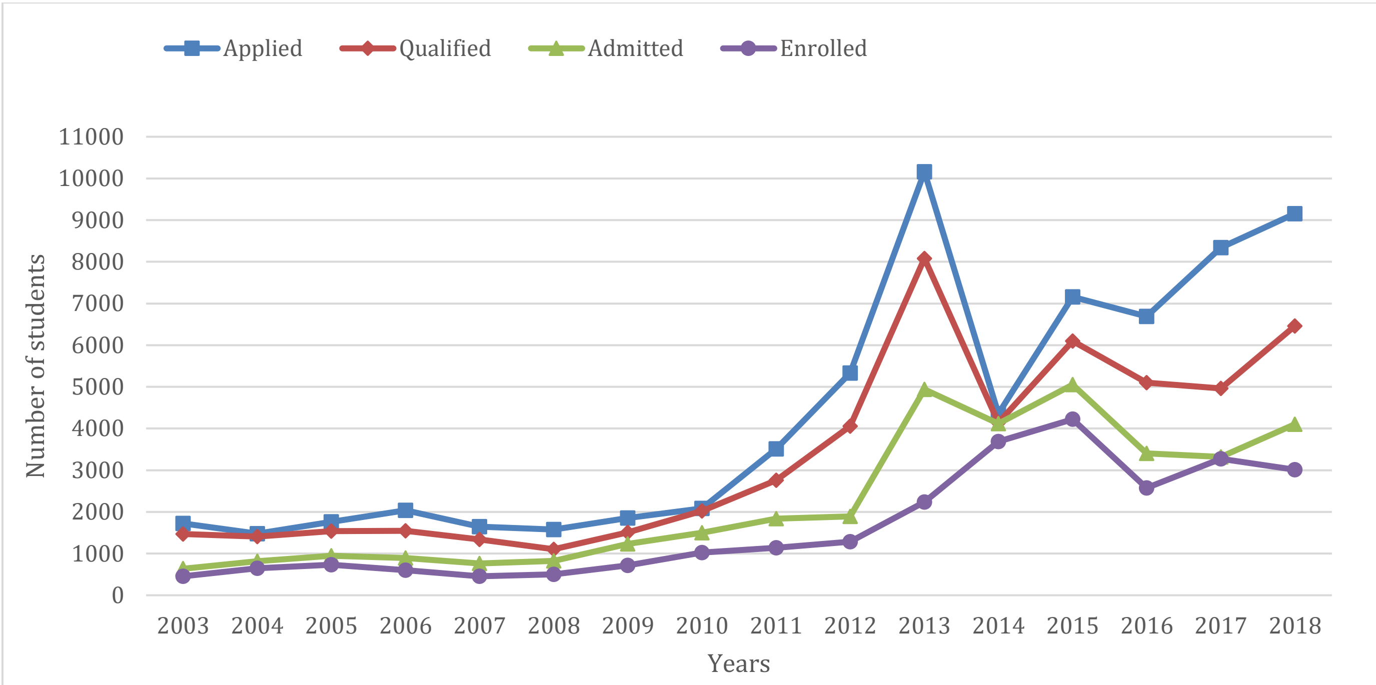


Fig 3: Time Series plot of the admission process for females in STEM programmes at KNUST (2003-2018)

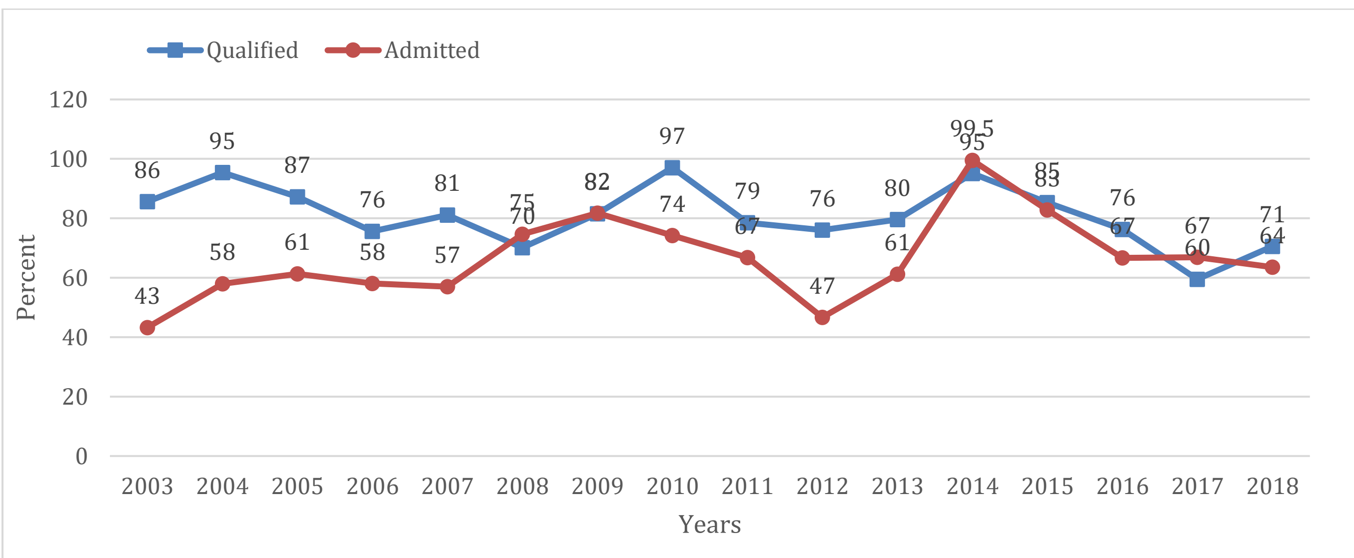


Fig 4 - Percentage of qualified and admitted female students of KNUST into the STEM programme (2003-2018).

Female admission in the respective STEM Colleges

Table 2 shows the percentage of female students' admitted to the STEM programmes in KNUST from 2003-2018. This table indicates that few females applied for the STEM programmes, with the Colleges of Health Sciences recording a maximum (53.15%) and Engineering a minimum (12.01%). Out of the 12554 female applicants for the pure and applied sciences (College of Science), 86.36% were admitted, representing the highest intake of applicants into the STEM courses. This indicates a substantial increase in female enrollment in STEM programmes. Although more females applied to the College of Health Sciences as compared to the males, only 42.18% were admitted from the 49805 female applicants. This is due to the high demands for nursing and midwifery programmes by females in the college.

Table 2: Admitted students into the STEM programme at KNUST

College	Total No. Applied	No. Applied		% of Applied female students	Total No. Admitted	No. Admitted		% of female students Admitted from female Application
		M	F	% F		M	F	
ENGINEERING	54145	47643	6,502	12.01	29,717	25,269	4,448	68.41
HEALTH SCIENCES	93702	43897	49,805	53.15	35,067	14,061	21,006	42.18
SCIENCE	43985	31431	12,554	28.54	34,468	23,627	10,842	86.36

Source: KNUST Basic Statistics key: Male (M), Female (F), percentage of female (%F), Number (No.)

From Fig. 5, it is observed that more males have been admitted to KNUST over the years. The year 2018 recorded the highest number of admitted male students whiles that of admitted females was in 2015. Nonetheless, 2003 recorded the minimum number of admitted students for both genders. Yet, it was only in 2013, when the university admitted two batches of SHS graduates and implemented a policy to deliberately increase female enrolment into the STEM programmes which witnessed a substantial increase in enrollment for female students pursuing programmes in STEM. These strategies resulted in the significant increase in the number of females admitted in KNUST which surpassed that of the males.

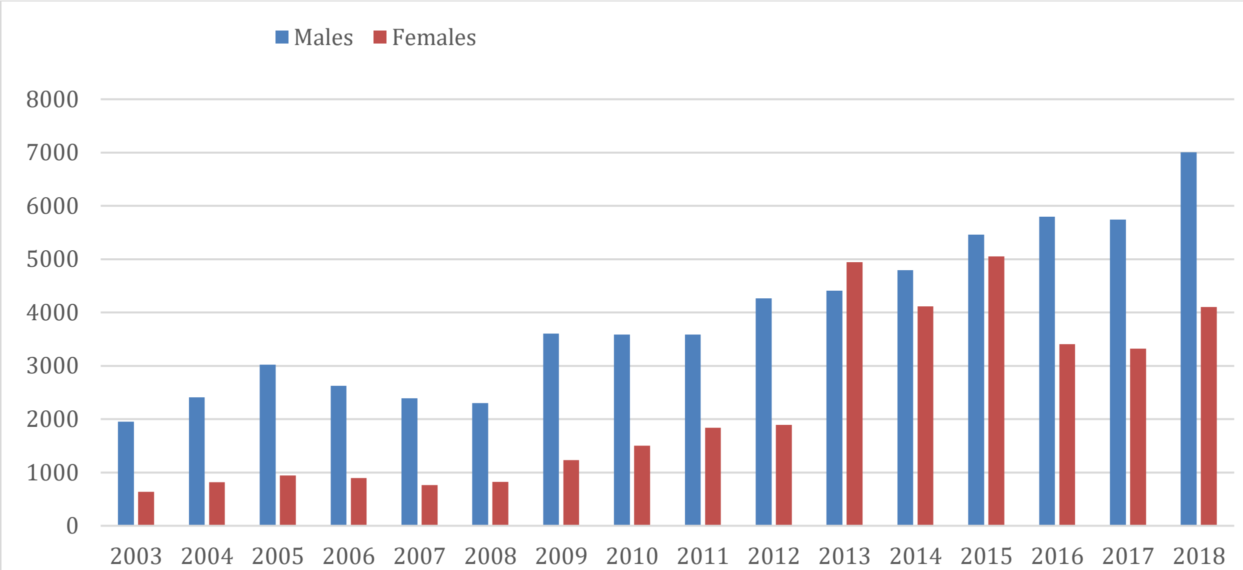


Fig 5: KNUST admitted student for STEM programmes from 2003- 2018 by gender

Females Enrolment in STEM at KNUST

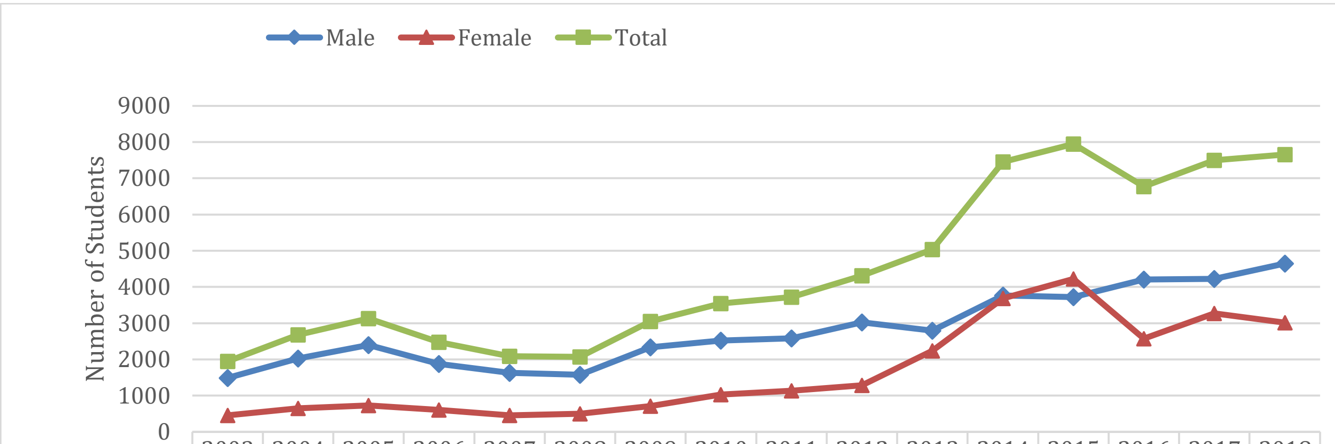
Table 3 shows the proportion of female enrolled students into the STEM programmes at KNUST. Not factoring the year of enrolment into consideration, it is obvious that KNUST has more females offering courses in the health sciences than in the pure and applied sciences and the engineering courses. Additionally, few females are enroled into the programmes since they have some inherent reservations for studying those programmes. Again, some females have the notion that some STEM jobs like engineering are for males. The results from the Table indicate that female enrolment seemed good in the college of health sciences than that of the males. Out of 38334 qualified applicants, only 43.74% of the females were enroled into the university.

Table 3: Percentage of enroled female students in KNUST

	Total	M	F	%F	%F enroled from qualified
ENGINEERING	21,200	18,235	2,964	13.71	55.78
HEALTH SCIENCES	27,761	10,992	16,769	51.53	43.74
SCIENCE	22,422	15,588	6,847	30.09	68.77

Sources: KNUST Basic Statistics

Fig 6 shows the enrolment trend by gender at KNUST from 2003-2018. The figure shows that more males are being enroled into KNUST over the successive years while there was a turnaround in 2015. Atuahene and Owusu-Ansah, (2013) argue that enrolment of female students keeps rising at both the primary and the secondary level, however, there is a major concern on its minimal impact on intake in the tertiary cycle. Nonetheless, female students’ access to higher education has still not seen much improvement despite the rise in the awareness to correct the gender-based disparity.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Male	1490	2026	2395	1878	1629	1573	2334	2522	2583	3025	2797	3764	3725	4204	4223	4,647
Female	456	650	732	603	456	501	716	1025	1139	1283	2237	3690	4222	2573	3275	3,011
Total	1946	2676	3127	2481	2085	2074	3050	3547	3722	4308	5034	7454	7947	6777	7498	7,658

Fig.6: Enrolment by Gender for STEM programmes – KNUST.

Table 4 presents both the Mann-Kendall test and the ADF test result which demonstrates the trend of female enrolment in KNUST. At a significance level of 0.05, the results for the Mann-Kendall show that there is a significant trend in the number of female enrolled students. Hence, there is an increasing trend in the number of KNUST female enrolled students into the STEM programme over the years. The p-value associated with the female enrolment series is greater than 0.05 significance level and therefore we can conclude that the female enrolment data over the sixteen-year period is not stationary; therefore showing a possible trend in the data.

Table 4: Trend of female enroled students at KNUST

Mann Kendall trend test		
Test Statistic	tau	p-value
4.4167	0.8285	0.0001
Unit Root (ADF) Test		
Test Statistic	P-Value	Decision
-2.2751	0.4676	Series is not stationary

Conclusions

Family attitudes towards female employment and how it affects a woman's ability to combine both work and family tasks are regularly recognized as important considerations regarding women's access to work and remain within the workforce. Women's participation in science and technology education has been and remains low worldwide. However, the trend in KNUST-Ghana indicates a progression towards female enrollment in STEM courses, specifically in the health sciences. The total percentage of women in science and engineering in KNUST remains lower than that of men. Although our society recognizes STEM as a strengthening field for women, there still a shortage of female students pursuing STEM education. From the graph for gender enrollment in STEM programmes, it is clear that there is an increasing trend in female enrollment at KNUST. Confirmatory trend tests (Mann-Kendall and the ADF) show that there is also a significant increasing trend. This implies that the interventions introduced by KNUST have a significant positive effect.

There is the need for a change in the approach of enroling and retaining girls' interest in the Sciences, Technology, Engineering and Mathematics (STEM) in higher education. It has been observed that applicants who believe in their abilities in mathematics are likely to study any of the STEM programmes. Continuous evaluation of the admission policy is necessary to specify a quota or percentage of qualified female students to be admitted to STEM courses so that the country can benefit from women's contributions in the STEM profession. This calls for government intervention to develop policies that encourage greater participation of girls in STEM courses. Such measures may include assurance of immediate employment for females upon graduation, grants and scholarship awards for females enrolled in STEM programmes, and intentional admission quotas to be awarded to female students or applicants to ensure that much more are enrolled.

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